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jc915 U.S. PTO 10/27/00

jc922 U.S. PTO 09/699198 10/27/00

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No 004906.P003 Pages 5

First Named Inventor or Application Identifier Suhail Nanji

Express Mail Label No. EL672753151US

ADDRESS TO: **Assistant Commissioner for Patents**
Box Patent Application
Washington, D. C. 20231

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

1. X Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)

2. X Specification (Total Pages 21)
(preferred arrangement set forth below)
- Descriptive Title of the Invention
- Cross References to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings (if filed)
- Detailed Description
- Claims
- Abstract of the Disclosure

3. X Drawings(s) (35 USC 113) (Total Sheets 6)

4. X Oath or Declaration (Total Pages 5 signed)

a. X Newly Executed (Original or Copy)

b. ___ Copy from a Prior Application (37 CFR 1.63(d))
(for Continuation/Divisional with Box 17 completed) **(Note Box 5 below)**

i. ___ DELETIONS OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

5. ___ Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. ___ Microfiche Computer Program (Appendix)

7. ___ Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
a. ___ Computer Readable Copy
b. ___ Paper Copy (identical to computer copy)
c. ___ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. X Assignment Papers (cover sheet & documents(s))

9.	____	a. 37 CFR 3.73(b) Statement (where there is an assignee)
	X	b. Power of Attorney
10.	____	English Translation Document (if applicable)
11.	____	a. Information Disclosure Statement (IDS)/PTO-1449
	____	b. Copies of IDS Citations
12.	____	Preliminary Amendment
13.	X	Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
14.	____	a. Small Entity Statement(s)
		b. Statement filed in prior application, Status still proper and desired
15.	____	Certified Copy of Priority Document(s) (if foreign priority is claimed)
16.	X	Other: Copy of postcard with Express Mail Certificate of Mailing

17. **If a CONTINUING APPLICATION,** check appropriate box and supply the requisite information:

___ Continuation ____ Divisional ____ Continuation-in-part (CIP)

of prior application No: _____

18. **Correspondence Address**

____ Customer Number or Bar Code Label _____ (Insert Customer No. or Attach Bar Code Label here)

or

X Correspondence Address Below

NAME Daniel M. DeVos, Reg. #37,813

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

ADDRESS 12400 Wilshire Boulevard

Seventh Floor

CITY Los Angeles STATE California ZIP CODE 90025-1026

Country U.S.A. TELEPHONE (408) 720-8300 FAX (408) 720-9397

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FEE TRANSMITTAL FOR FY 2001

TOTAL AMOUNT OF PAYMENT ($) **$1992.00**

Complete if Known:
Application No.
Filing Date October 27, 2000
First Named Inventor Suhail Nanji
Group Art Unit
Examiner Name
Attorney Docket No. 004906.P003

METHOD OF PAYMENT (check one)

1. [ ] **The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:**

   Deposit Account Number 02-2666
   Deposit Account Name

   [X] **Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17**

2. X **Payment Enclosed:**
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   Money Order
   Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	710	201	355	Utility application filing fee	710.00
106	320	206	160	Design application filing fee	
107	490	207	245	Plant filing fee	
108	710	208	355	Reissue filing fee	
114	150	214	75	Provisional application filing fee	

SUBTOTAL (1) **$ 710.00**

2. EXTRA CLAIM FEES

		Extra Claims		Fee from below		Fee Paid
Total Claims	49	– 20** =	29	X 18.00	=	$522.00
Independent Claims	12	– 3** =	9	X 80.00	=	$720.00
Multiple Dependent					=	

****Or number previously paid, if greater; For Reissues, see below.**

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	80	202	40	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	80	209	40	**Reissue independent claims over original patent
110	18	210	9	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) **$ 1242.00**

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	

127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for response within first month	
116	390	216	195	Extension for response within second month	
117	890	217	445	Extension for response within third month	
118	1,390	218	695	Extension for response within fourth month	
128	1,890	228	945	Extension for response within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive unavoidably abandoned application	
141	1,240	241	620	Petition to revive unintentionally abandoned application	
142	1,240	242	620	Utility issue fee (or reissue)	
143	440	243	220	Design issue fee	
144	600	244	300	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	$40.00
146	710	246	355	For filing a submission after final rejection (see 37 CFR 1.129(a))	
149	710	249	355	For each additional invention to be examined (see 37 CFR 1.129(b))	
179	710	279	355	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify) _____

Other fee (specify) _____

SUBTOTAL (3) $ 40.00

*Reduced by Basic Filing Fee Paid

SUBMITTED BY:

Typed or Printed Name: Daniel M. DeVos

Signature: _____ Date: 10/27/00

Reg. Number: 37,813 Telephone Number: (408) 720-8300

EXPRESS MAIL CERTIFICATE OF MAILING

"Express Mail" mailing label number: EL672753151US
Date of Deposit: 10/27/00
I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to the Assistant Commissioner for Patents, Washington, D. C. 20231

D. Roberts
(Typed or printed name of person mailing paper or fee)

D. Roberts
(Signature of person mailing paper or fee)

10/27/00
(Date signed)

Serial/Patent No.: **** Filing/Issue Date: 10/27/2000
Client: Redback Networks, Inc.
Title: TUNNELING ETHERNET

BSTZ File No.: 004906.P003 Atty/Secty Initials: DMD/dkr
Date Mailed: 10/27/2000 Docket Due Date: ****

The following has been received in the U.S. Patent & Trademark Office on the date stamped hereon:

- ☐ Amendment/Response (____ pgs.)
- ☐ Appeal Brief (____ pgs.) (in triplicate)
- ■ Application - Utility (21 pgs., with cover and abstract)
- ☐ Application - Rule 1.53(b) Continuation (____ pgs.)
- ☐ Application - Rule 1.53(b) Divisional (____ pgs.)
- ☐ Application - Rule 1.53(b) CIP (____ pgs.)
- ☐ Application - Rule 1.53(d) CPA Transmittal (____ pgs.)
- ☐ Application - Design (____ pgs.)
- ☐ Application - PCT (____ pgs.)
- ☐ Application - Provisional (____ pgs.)
- ■ Assignment and Cover Sheet 4 Pgs
- ■ Certificate of Mailing Express Mail
- ■ Declaration & POA (5 pgs.) Signed
- ☐ Disclosure Docs & Orig & Copy of Inventors Signed Letter (____ pgs)
- ■ Drawings: 6 # of sheets includes 7 figures
- ■ Express Mail No.: EL672753151US ■ Check No 38566
- ☐ _____ Month(s) Extension of Time Amt $1,992.00
- ☐ ~~Information Disclosure Statement~~ & PTO-1449 (__ pgs.) ■ Check No 38572
- ☐ Issue Fee Transmittal Amt: $ 40.00
- ☐ Notice of Appeal
- ☐ Petition for Extension of Time
- ☐ Petition for _____
- ■ Postcard
- ☐ Power of Attorney (____ pgs.)
- ☐ Preliminary Amendment (____ pgs.)
- ☐ Reply Brief (____ pgs.)
- ☐ Response to Notice of Missing Parts
- ☐ Small Entity Declaration for Indep. Inventor/Small Business
- ■ Transmittal ~~letter~~, in duplicate Utility
- ■ Fee Transmittal, in duplicate

☐ Other: _____

UNITED STATES PATENT APPLICATION

FOR

TUNNELING ETHERNET

INVENTORS
SUHAIL NANJI

PREPARED BY:

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES, CA 90025-1026

(408) 720-8598

TUNNELING ETHERNET

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to the area of communication networks. More specifically, the present invention relates to preserving Ethernet frames across a network.

Description of the Related Art

Ethernet headers contain useful data. For example, the source address can be used for network analysis, tracing, billing and accounting purposes. Ethernet frames can be tunneled with the Bridge Encapsulation Protocol (BCP) and the Generic Routing Protocol (GRE).

Figure 1 (Prior Art) is a diagram of transmitting an Ethernet frame with Bridge Control Protocol (BCP) encapsulation. The subscriber's machine 101 (e.g. personal computer (PC)) runs the Internet Protocol (IP) and Ethernet. Data packets are prepared for transmittal to the Internet by prepending IP headers. The subscriber's machine 101 also prepends Ethernet headers onto the data packets to be transmitted. The encapsulation of the data is represented by the protocol stack 103. An encapsulated data packet is transmitted to the customer premise equipment (CPE) 105, such as a cable modem or digital subscriber line (DSL) modem. To preserve the Ethernet frame with BCP, the CPE 105 must run BCP and the Point to Point Protocol (PPP). The CPE 105 encapsulates the data from the subscriber machine 103 with BCP and then PPP. The CPE further prepares the data for transmission by encapsulating the data in delivery protocols (such as 1483 or 1490 bridged circuit over Asynchronous Transmission Mode (ATM), Frame Relay, etc) as indicated by the protocol stack 107. The protocol stack 107 is transmitted to a network element 109. The network element may support BCP and PPP to decapsulate the data packet. The network element 109 is configured as a Layer 2

Tunneling Protocol (L2TP) Access Concentrator (LAC) in order to tunnel the stack or data packet. The LAC 109 encapsulates the data packet with L2TP as indicated by the stack 111 for transmission to an L2TP Network Server (LNS) 113. The LNS 113 must support PPP and BCP to decapsulate the data packet.

Figure 2 (Prior Art) is a diagram of transmitting traffic from multiple subscribers who use different protocols with multiple Generic Routing Encapsulation (GRE) tunnels. Two individual subscribers 201, 202 connect to two separate CPEs 213, 206. The traffic transmitted from the subscribers 201, 202 to the CPEs 213, 206 are IP encapsulated with Ethernet as indicated by the protocol stacks 205, 204. The CPEs 213, 206 encapsulate the subscriber traffic in a delivery protocol, as indicated by the protocol stacks 209 and 210, and transmit the traffic to a network element 217. Another subscriber 203 transmits traffic to a CPE 215 encapsulated with Point to Point protocol as indicated by the protocol stack 207 showing IP over PPP. The CPE 215 encapsulates the subscriber traffic in a delivery protocol as indicated by the protocol stack 211 and transmits the traffic to a network element 217. The network element 217 uses GRE to tunnel the traffic from subscribers 201, 202, and 203 to another network element 227. The network element 217 establishes 2 different tunnels 223, 225 with the network element 227. One tunnel 223 carries both subscribers' Ethernet traffic. The Ethernet traffic is indicated by the protocol stack 221. The other tunnel 225 carries the PPP subscriber traffic indicated by the protocol stack 219. Both GRE tunnels must be transmitted by IP media also indicated by stacks 221 and 219. The network element 227 terminates the tunnels 223, 225 and routes the traffic to the Internet 229.

Although BCP can be employed to transmit an Ethernet frame, it is an inefficient method. Both PPP and BCP must be supported on the network elements processing BCP data packets. In addition to the network elements, the CPE must also support BCP which is atypical. Moreover, BCP support is in addition to whatever tunneling protocol is to be used. Utilizing GRE to transmit Ethernet frames presents a more efficient and simple

method than BCP, but GRE does not have the robust signaling integral to L2TP. Customers requesting certain information passed as attribute values pairs (AVPs) in L2TP lose the option of receiving such information with GRE.

SUMMARY OF THE INVENTION

The invention provides an apparatus and method for transmitting Ethernet data. According to one aspect of the invention, a method provides for transmitting Ethernet frames over a tunneling protocol.

In one embodiment of the invention, an Ethernet frame is received and transmitted over a non-homogenous tunnel, the tunnel having a plurality of sessions. Requested values are also transmitted over the non-homogenous tunnel.

In an alternative embodiment of the invention, Ethernet data included in an Ethernet frame is transmitted over a non-homogenous L2TP tunnel to a service provider. Upon receiving the Ethernet data, the service provider analyzes the Ethernet data.

In another embodiment of the invention, an Ethernet frame is encapsulated with L2TP, transmitted over a network, and decapsulated. The Ethernet frame is transmitted on one of a plurality of sessions in a non-homogenous tunnel running over the network. Attribute value pairs (AVPs) are transmitted over the session in relation to the encapsulated Ethernet frame.

These and other aspects of the present invention will be better described with reference to the Detailed Description of the Preferred Embodiment and the accompanying Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may best be understood by referring to the following description and accompanying drawings that are used to illustrate embodiments of the invention. In the drawings:

The invention may best be understood by referring to the following description and accompanying drawings that are used to illustrate embodiments of the invention. In the drawings:

Figure 1 (Prior Art) is a diagram of transmitting an Ethernet frame with Bridge Control Protocol (BCP) encapsulation.

Figure 2 (Prior Art) is a diagram of transmitting traffic from multiple subscribers who use different protocols with multiple Generic Routing Encapsulation (GRE) tunnels.

Figure 3 is a diagram of transmitting traffic from multiple subscribers who use different protocols over a single Ethernet capable Layer 2 Tunneling Protocol (L2TP) tunnel according to one embodiment of the invention.

Figure 4A is a diagram illustrating establishing an Ethernet capable tunnel between a LAC and LNS according to one embodiment of the invention.

Figure 4B is a diagram illustrating establishment of an Ethernet over L2TP session between a LAC and LNS according to one embodiment of the invention.

Figure 5 is a flowchart of a LAC processing traffic according to one embodiment of the invention.

Figure 6 is a flowchart for processing traffic received from a session in an Ethernet capable L2TP tunnel according to one embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

The present invention provides for a method and apparatus for transmitting Ethernet frames across a network. In the following description, numerous specific details are set forth to provide a thorough understanding of the invention. However, it is understood that the invention may be practiced without these specific details. In other instances, well-known protocols, structures and techniques have not been shown in detail in order not to obscure the invention.

Figure 3 is a diagram of transmitting traffic from multiple subscribers who use different protocols over a single Ethernet capable Layer 2 Tunneling Protocol (L2TP) tunnel according to one embodiment of the invention. Two individual subscribers 301, 302 connect to individual CPEs 305 and 306 with Ethernet. The subscribers transmit IP packets encapsulated with Ethernet as indicated by the protocol stacks 303, 304 to the CPEs 305 and 306. The CPEs 305 and 306 encapsulate the Ethernet traffic with a delivery protocol as indicated by the protocol stacks 307 and 308 and transmit the two stacks to a network element 317. Another subscriber 309 transmits IP packets with PPP as indicated by the protocol stack 311. The subscriber traffic is transmitted to a CPE 313 which encapsulates the traffic with a delivery protocol as indicated by the protocol stack 315. This encapsulated traffic is transmitted to the network element 317. The network element 317 establishes a single L2TP tunnel 318 to a network element 329. The traffic from all three subscribers 301, 309, and 302 are transmitted to the network element 329 over the same non-homogenous tunnel 318, but in separate sessions. The traffic from subscriber 301 represented by the stack 321 is transmitted by session 325. The traffic from subscriber 309 represented by the stack 323 is transmitted by session 327, while the traffic from subscriber 302 represented by the stack 312 is transmitted by session 310. The network element 329 transmits traffic to the Internet 331.

As illustrated by Figure 3 and Figure 2, transmitting Ethernet with L2TP has multiple advantages over transmitting Ethernet with GRE. GRE must establish homogenous tunnels; a tunnel is established for the subscriber connecting with PPP and a separate tunnel is established for the subscribers using Ethernet. Administration and management of multiple tunnels requires more resources and processing for a network element than maintaining a single tunnel. A single non-homogenous tunnel can be established with the extension to L2TP described herein. Thus, transmitting Ethernet with this extension to L2TP instead of GRE reduces the resource consumption of the network element terminating the tunnel. The network element acting as an L2TP tunnel

endpoint uses less resources and can process more traffic than the same network element acting as a GRE tunnel endpoint in situations like that shown in Figure 3. Exemplary techniques for implementing non-homogenous L2TP tunnels that can carry Ethernet are described in more detail later herein..

Figures 4A-4B are diagrams illustrating establishment of an Ethernet capable tunnel and an Ethernet over L2TP session between a LAC and an LNS. Figure 4A is a diagram illustrating establishing an Ethernet capable tunnel between a LAC and LNS according to one embodiment of the invention. The LAC 401 creates and transmits an L2TP Start-Control Connection Request (SCCRQ) or tunnel request control message 405 to the LNS 403 for tunnel setup (it is understood that a network element can act as both a LAC and an LNS). The tunnel request control message 405 indicates to the LNS 403 that the LAC might transmit L2TP encapsulated Ethernet frames. The LNS 403 transmits Start-Control-Reply (SCCRP) or a tunnel reply control message 407 to the LAC 401 confirming its ability to process an Ethernet frame. If a tunnel is established between the LAC 401 and the LNS 403, then a session must be established to actually transmit data.

Figure 4B is a diagram illustrating establishment of an Ethernet over L2TP session between a LAC and LNS according to one embodiment of the invention. The LAC 401 transmits Incoming Call Request (ICRQ) or a session request control message 409 to the LNS 403. The request control message 409 indicates to the LNS that Ethernet frames are being transmitted in the L2TP session and indicates the Ethernet Media Access Control (MAC) Address of the LAC. When the LNS transmits traffic to the subscriber, the LNS uses this MAC address as the source address of the traffic being transmitted to the subscriber. After a session is established between the LAC and LNS, the LAC begins to transmit Ethernet over L2TP data packets to the LNS 403.

Figure 5 is a flowchart of a LAC processing traffic according to one embodiment of the invention. At block 500 a LAC listens for traffic on a bridged circuit or Ethernet port. At block 501, the LAC receives traffic on the bridged circuit or Ethernet port. The

LAC determines if the received traffic is to be tunneled at block 503. The LAC then queries a database such as RADIUS for tunnel parameters. If a failing event occurs which prevents the LAC from receiving tunnel parameters, then at block 507 the bridged circuit or Ethernet port is paused for a configured amount of time before returning control to block 500. A failing even can include a communication failure between the LAC and the database, the database not finding tunnel parameters, etc. If the LAC does attain tunnel parameters, then at block 509 the LAC attempts to establish a tunnel with an LNS. If the tunnel setup fails, then control goes to block 507. If the tunnel is established, then the LAC requests a session over the tunnel with the LNS and indicates Ethernet and the LAC's MAC address at block 511. If the session setup fails, then control flows to block 507. If session setup is successful, then the LAC begins to transmit the data traffic to the LNS at block 513. Although the described embodiment pauses after all three failing scenarios, alternative embodiments can pause for select failing events or not pause.

Figure 6 is a flowchart for an LNS processing traffic received over a session in an Ethernet capable L2TP tunnel from a LAC according to one embodiment of the invention. At block 601, an LNS receives an Incoming-Call-Request (ICRQ) or session control message from a LAC to establish an L2TP session. An AVP in the ICRQ control message indicates the session type to be transmitted from the LAC. At block 603, the LNS determines if the session request control message indicates Ethernet. If the control message does indicate Ethernet, then a virtual circuit structure is created indicating Ethernet encapsulation at block 607. Otherwise, the LNS creates a virtual circuit structure at block 605 indicating a different encapsulation. At block 608 the LNS receives an L2TP data packet over the session. When the LNS receives the L2TP packet from the session, a decapsulation routine removes the L2TP header from the packet to get a payload at block 609. The LNS then associates the decapsulated payload with the virtual circuit structure at block 611. The LNS processes the payload as indicated by the virtual circuit structure at block 613. If the virtual circuit indicates Ethernet

encapsulation, the virtual circuit structure creates the impression to the system of the LNS that the payload is a data packet received on an Ethernet port. If the virtual circuit structure indicates a different encapsulation, then it creates the impression to the LNS system that the payload was received on a circuit configured for the different encapsulation.

The capability to transmit Ethernet frames over L2TP tunnels increases functionality of a network element supporting this extension to L2TP. This extension of L2TP covers the two network layer protocols most likely employed by subscribers. The wholesale network provider can employ L2TP to provide ISP customers individual data streams for each subscriber accessing the network through the wholesale network provider's network element. L2TP also enables a network provider with robust signaling functionality. With L2TP, the network provider can satisfy a customer request for certain information to be passed as AVPs. The flexibility of L2TP allows the network provider to add and remove AVPs in response to the changing needs of customers. Other protocols such as GRE do not support this signaling functionality. Moreover, additional protocols are unnecessary as with BCP.

In addition, GRE is limited to IP media which is more complex and has more overhead than other media such as Frame Relay. In contrast, L2TP can be carried over any media.

The techniques shown in the figures can be implemented using code and data stored and executed on computers. Such computers store and communicate (internally and with other computers over a network) code and data using machine-readable media, such as magnetic disks; optical disks; random access memory; read only memory; flash memory devices; electrical, optical, acoustical or other form of propagated signals (e.g., carrier waves, infrared signals, digital signals, etc.); etc. Of course, one or more parts of the invention may be implemented using any combination of software, firmware, and/or hardware.

While the invention has been described in terms of several embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described. In an alternative embodiment, the data stored in an Ethernet header can be transmitted instead of the Ethernet frame. The Ethernet payload could be decapsulated from the Ethernet frame. The data in the Ethernet frame could be stored as values in the L2TP header. Hence, the Ethernet information could be transmitted with L2TP instead of encapsulating the Ethernet frame with L2TP. In another embodiment of the invention, Ethernet could be transmitted over L2TP and PPP. A virtual PPP client would run on the LAC. The Ethernet frame could be encapsulated with the virtual PPP client, and the Ethernet frame transmitted within PPP encapsulation without extending L2TP.

The method and apparatus of the invention can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of limiting on the invention

We claim:

1. A machine readable medium that provides instructions, which when executed by a set of processors, cause said set of processors to perform operations comprising:

receiving an Ethernet frame; and

transmitting the Ethernet frame over a non-homogenous tunnel, the tunnel distinguishing subscriber traffic.

2. The machine readable medium of claim 1 further comprising transmitting requested values over the non-homogenous tunnel.

3. The machine readable medium of claim 1 wherein the Ethernet frame is transmitted on one of the plurality of sessions.

4. A machine readable medium that provides instructions, which when executed by a set of processors, cause said set of processors to perform operations comprising:

transmitting a set of Ethernet data included in an Ethernet frame with Layer 2 Tunneling Protocol (L2TP); and

transmitting the set of Ethernet data to a service provider.

5. The machine readable medium of claim 4 further comprising the service provider analyzing the set of Ethernet data.

6. The machine readable medium of claim 4 wherein the set of Ethernet data is transmitted over a non-homogenous L2TP tunnel.

7. The machine readable medium of claim 4 wherein the transmitting the set of Ethernet data comprises encapsulating the Ethernet frame with L2TP.

8. The machine readable medium of claim 7 wherein the encapsulating the Ethernet frame comprises:

establishing an L2TP tunnel capable of carrying the Ethernet frame;

establishing an L2TP session for carrying the Ethernet frame; and

prepending L2TP headers onto the Ethernet frame.

9. A machine readable medium that provides instructions, which when executed by a set of processors, cause said set of processors to perform operations comprising:

encapsulating an Ethernet frame in Layer 2 Tunneling Protocol (L2TP); and

transmitting the L2TP encapsulated Ethernet frame over a network; and

decapsulating the Ethernet frame from L2TP.

10. The machine readable medium of claim 9 wherein the L2TP encapsulated Ethernet frame is transmitted on one of a plurality of sessions of a non-homogenous tunnel.

11. The machine readable medium of claim 9 wherein transmitting the Ethernet frame further comprises transmitting attribute value pairs (AVPs) in relation to the Ethernet frame.

12. The machine readable medium of claim 9 wherein transmitting the frame comprises:

establishing an Ethernet capable L2TP tunnel; and

establishing an L2TP session to carry the frame; and

transmitting a MAC address.

13. The machine readable medium of claim 9 further comprising performing session fail retry.

14. A machine readable medium that provides instructions, which when executed by a set of processors, cause said set of processors to perform operations comprising:

establishing a Layer 2 Tunneling Protocol (L2TP) tunnel capable of carrying an Ethernet frame ;

establishing an L2TP session to carry the Ethernet frame;

transmitting the Ethernet frame in L2TP encapsulation over the L2TP session; and

decapsulating the frame.

15. The machine readable medium of claim 14 wherein the L2TP tunnel is non-homogenous.

16. The machine readable medium of claim 14 wherein establishing the L2TP session comprises performing session fail retry.

17. The machine readable medium of claim 14 wherein establishing the L2TP tunnel capable of carrying the Ethernet frame comprises transmitting an L2TP control message indicating a tunnel capable of carrying the Ethernet frame.

18. The machine readable medium of claim 14 further comprising performing session fail retry.

19. A machine readable medium that provides instructions, which when executed by a set of processors, cause said set of processors to perform operations comprising:

transmitting a first tunnel control message for Layer 2 Tunneling Protocol (L2TP) tunnel setup having

an attribute value pair (AVP) indicating Ethernet frame capability,

receiving a second tunnel control message for L2TP tunnel setup having an AVP indicating Ethernet frame capability;

transmitting a session control message having an AVP indicating an L2TP Ethernet session and an AVP indicating an Ethernet Media Access Control (MAC) address; and

transmitting an Ethernet frame with the L2TP Ethernet session.

20. The machine readable medium of claim 19 further comprising performing session fail retry before transmitting the Ethernet frame.

21. The machine readable medium of claim 19 wherein transmitting the first and second tunnel control messages comprises manipulating the bits of the first and second tunnel control messages.

22. A machine readable medium that provides instructions, which when executed by a set of processors, cause said set of processors to perform operations comprising:

establishing an Ethernet capable Layer 2 Tunneling Protocol (L2TP) tunnel;

accepting an L2TP session;

receiving an L2TP encapsulated Ethernet frame over the session;

decapsulating the Ethernet frame; and

associating the Ethernet frame to a virtual circuit structure.

23. The machine readable medium of claim 22 wherein the tunnel is non-homogenous.

24. The machine readable medium of claim 22 wherein establishing the Ethernet capable L2TP tunnel comprises:

receiving a first tunnel control message indicating Ethernet capability; and

transmitting a second tunnel control message indicating Ethernet frame capability.

25. The machine readable medium of claim 22 wherein accepting the L2TP session comprises:

receiving a session control message indicating session type and an Ethernet MAC address; and

creating a virtual circuit structure in response to the control message.

26. The machine readable medium of claim 22 further comprising extracting a set of data from the Ethernet frame.

27. The machine readable medium of claim 22 wherein the associating the Ethernet frame to the virtual circuit structure comprises processing the Ethernet frame as indicated by the virtual circuit structure.

28. A machine readable medium that provides instructions, which when executed by a set of processors, cause said set of processors to perform operations comprising:

receiving a first Layer 2 Tunneling Protocol tunnel control message having an attribute value pair (AVP) indicating Ethernet capability;

transmitting a second L2TP tunnel control message having an AVP indicating Ethernet capability;

receiving a session control message having an AVP indicating a session type and an Ethernet MAC address;

creating a virtual circuit structure for the session type in response to the session control message; and

processing an L2TP packet having a payload with the virtual circuit structure.

29. The machine readable medium of claim 28 wherein processing the L2TP packet comprises:

decapsulating the payload from the L2TP packet; and

processing the payload as indicated by the virtual circuit structure.

30. The machine readable medium of claim 28 wherein the first and second control messages include values requested by a customer.

31. An apparatus comprising:

a Layer 2 Tunneling Protocol (L2TP) Access Concentrator (LAC) to transmit an Ethernet frame over an L2TP tunnel; and

an Layer 2 Tunneling Protocol Network Server (LNS) to receive the Ethernet frame from the L2TP tunnel originating at the LAC.

32. The machine readable medium of claim 31 wherein the L2TP tunnel is non-homogenous.

33. The apparatus of claim 31 wherein the LAC to transmit the Ethernet frame comprises:

establishing an L2TP tunnel capable of carrying an Ethernet over L2TP session; and

establishing an Ethernet over L2TP session to the LNS.

34. The apparatus of claim 33 wherein establishing an L2TP tunnel capable of carrying an Ethernet over L2TP session comprises:

the LAC transmitting a first tunnel control message to the LNS indicating Ethernet frame capability; and

the LNS transmitting a second tunnel control message to the LAC indicating Ethernet frame capability.

35. The apparatus of claim 33 wherein the establishing the Ethernet over L2TP session to the LNS comprises the LAC transmitting to the LNS a session control message indicating Ethernet encapsulation and an Ethernet Media Access Control (MAC) address for the LAC.

36. A Layer 2 Tunneling Protocol (L2TP) Access Concentrator (LAC) comprising:

an operating system to establish an Ethernet capable L2TP tunnel with a peer,

to perform session fail retry;

to establish an Ethernet over L2TP session in the tunnel,

to encapsulate an Ethernet frame with L2TP; and

a circuit to transmit the session.

37. The LAC of claim 36 wherein to establish the Ethernet over L2TP session comprises transmitting signals, the signals including requested values.

38. The LAC of claim 36 wherein the tunnel is non-homogenous.

39. The LAC of claim 36 wherein to establish the Ethernet capable L2TP tunnel comprises:

transmitting a first tunnel control message indicating Ethernet frame capability; and

receiving a second tunnel control message indicating Ethernet frame capability.

40. The LAC of claim 36 wherein to establish the Ethernet over L2TP session in the tunnel comprises transmitting a session control message indicating Ethernet encapsulation and an Ethernet MAC address for the LAC.

41. A Layer 2 Tunneling Protocol (L2TP) Network Server (LNS) comprising:

an operating system to establish an Ethernet capable L2TP tunnel;

a circuit to receive an Ethernet over L2TP packet having an Ethernet frame as a payload; and

a logic to process the packet.

42. The LNS of claim 41 wherein the tunnel is non-homogenous.

43. The LNS of claim 41 wherein the operating system to establish the Ethernet capable L2TP tunnel comprises:

receiving a first tunnel control message indicating Ethernet capability; and

transmitting a second tunnel control message indicating Ethernet capability.

44. The LNS of claim 41 wherein the logic to process the packet comprises:

decapsulating the payload from L2TP encapsulation;

associating the payload with a virtual circuit structure; and

processing the payload as indicated by the virtual circuit structure.

45. A computer implemented method comprising:

receiving an Ethernet frame; and

transmitting the Ethernet frame over a non-homogenous tunnel, the tunnel having a plurality of sessions.

46. The method of claim 45 further comprising transmitting requested values over the non-homogenous tunnel.

47. The method of claim 45 wherein the Ethernet frame is transmitted on one of the plurality of sessions.

48. A computer implemented method comprising:

transmitting a first tunnel control message for Layer 2 Tunneling Protocol (L2TP) tunnel setup having

an attribute value pair (AVP) indicating Ethernet frame capability,

receiving a second tunnel control message for L2TP tunnel setup having an AVP indicating Ethernet frame capability;

transmitting a session control message having an AVP indicating an L2TP Ethernet session and an Ethernet Media Access Control (MAC) address; and

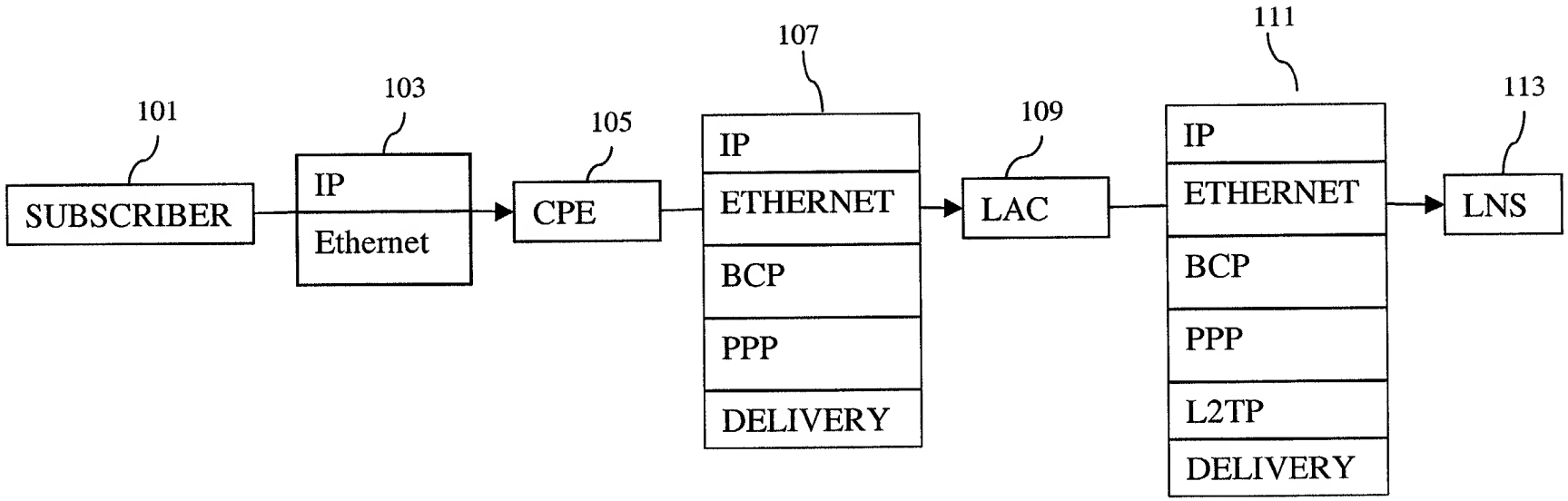
transmitting an Ethernet frame with the L2TP Ethernet session.

49. The method of claim 48 further comprising performing AAA retry before transmitting the Ethernet frame.

50. The method of claim 48 wherein transmitting the first and second tunnel control messages comprises manipulating the bits of the first and second tunnel control messages.

ABSTRACT OF THE DISCLOSURE

A machine readable medium for tunneling Ethernet is described. A machine readable medium comprises receiving an Ethernet frame and transmitting the Ethernet frame over a non-homogenous tunnel, the tunnel distinguishing subscriber traffic.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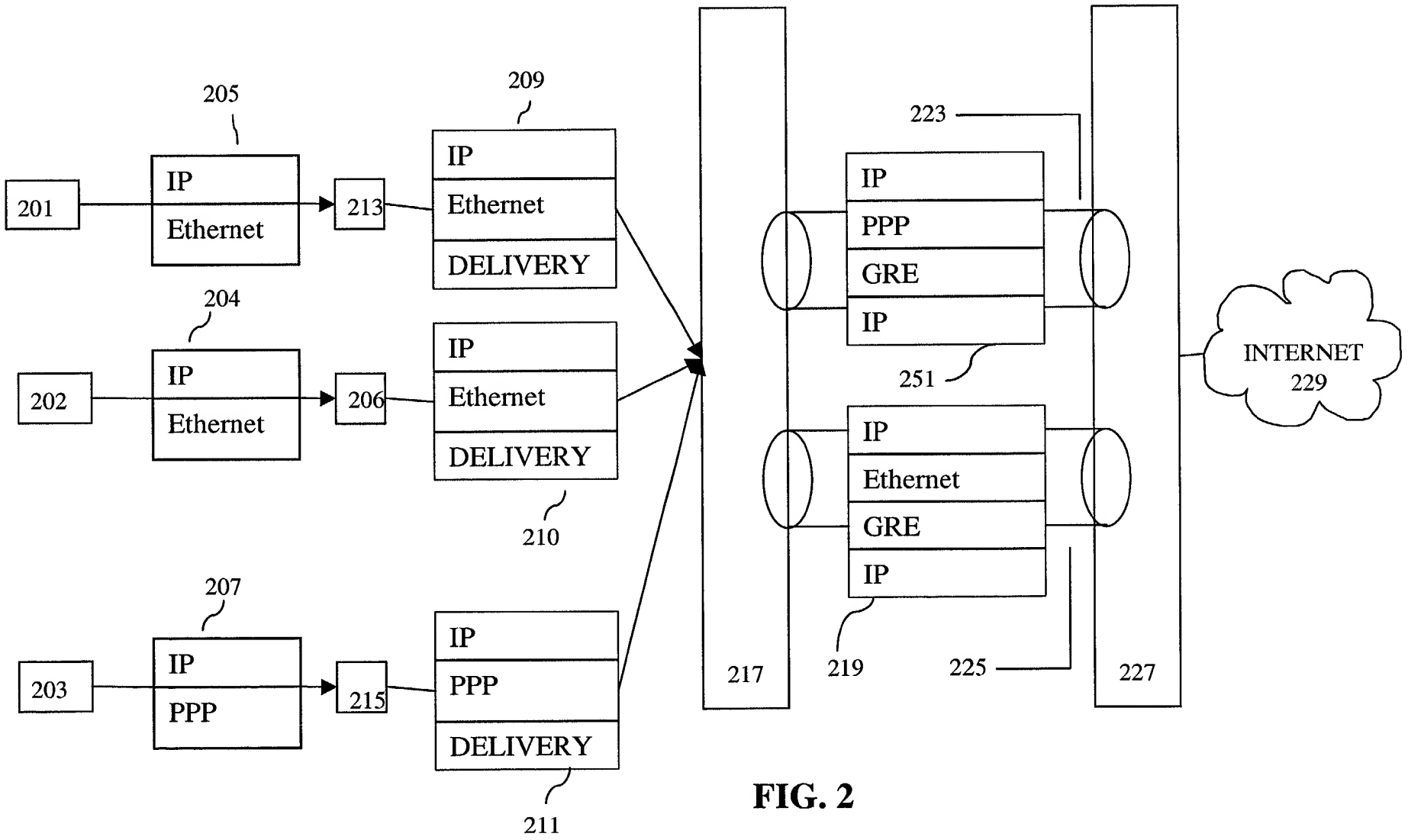
103
IP
Ethernet
105
CPE
107
IP
ETHERNET
BCP
PPP
DELIVERY
109
LAC
111
IP
ETHERNET
BCP
PPP
L2TP
DELIVERY
113
LNS

FIG. 1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223
201
IP
Ethernet
213
IP
Ethernet
DELIVERY
IP
PPP
GRE
IP
204
202
IP
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206
IP
Ethernet
DELIVERY
251
INTERNET
229
210
207
IP
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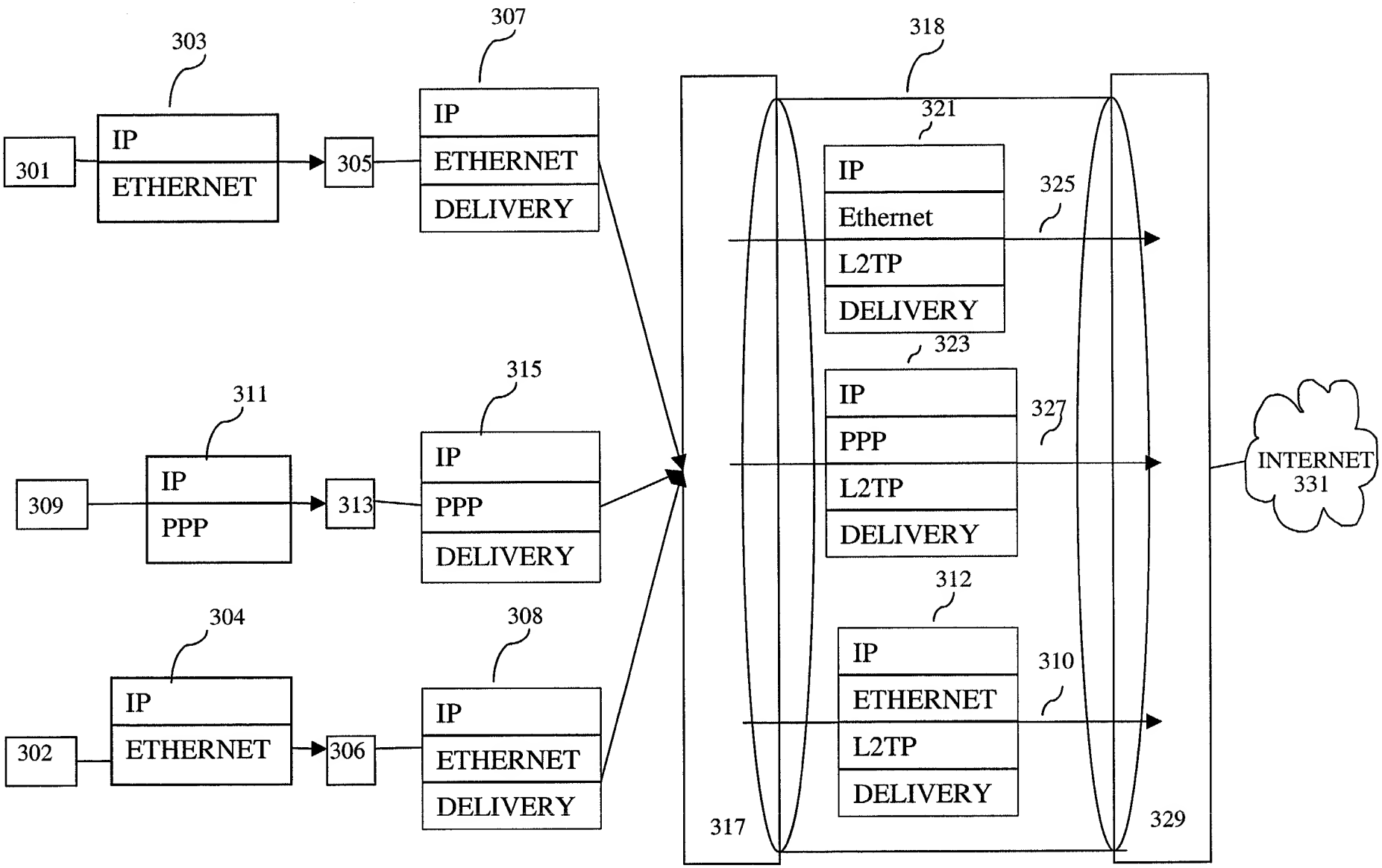
GRE
IP
203
IP
PPP
215
IP
PPP
DELIVERY
217
219
225
227
211

FIG. 2


303
307
318
321
301
IP
ETHERNET
305
IP
ETHERNET
DELIVERY
IP
Ethernet
L2TP
DELIVERY
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315
311
IP
PPP
309
313
IP
PPP
DELIVERY
327
IP
PPP
L2TP
DELIVERY
INTERNET
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312
304
308
IP
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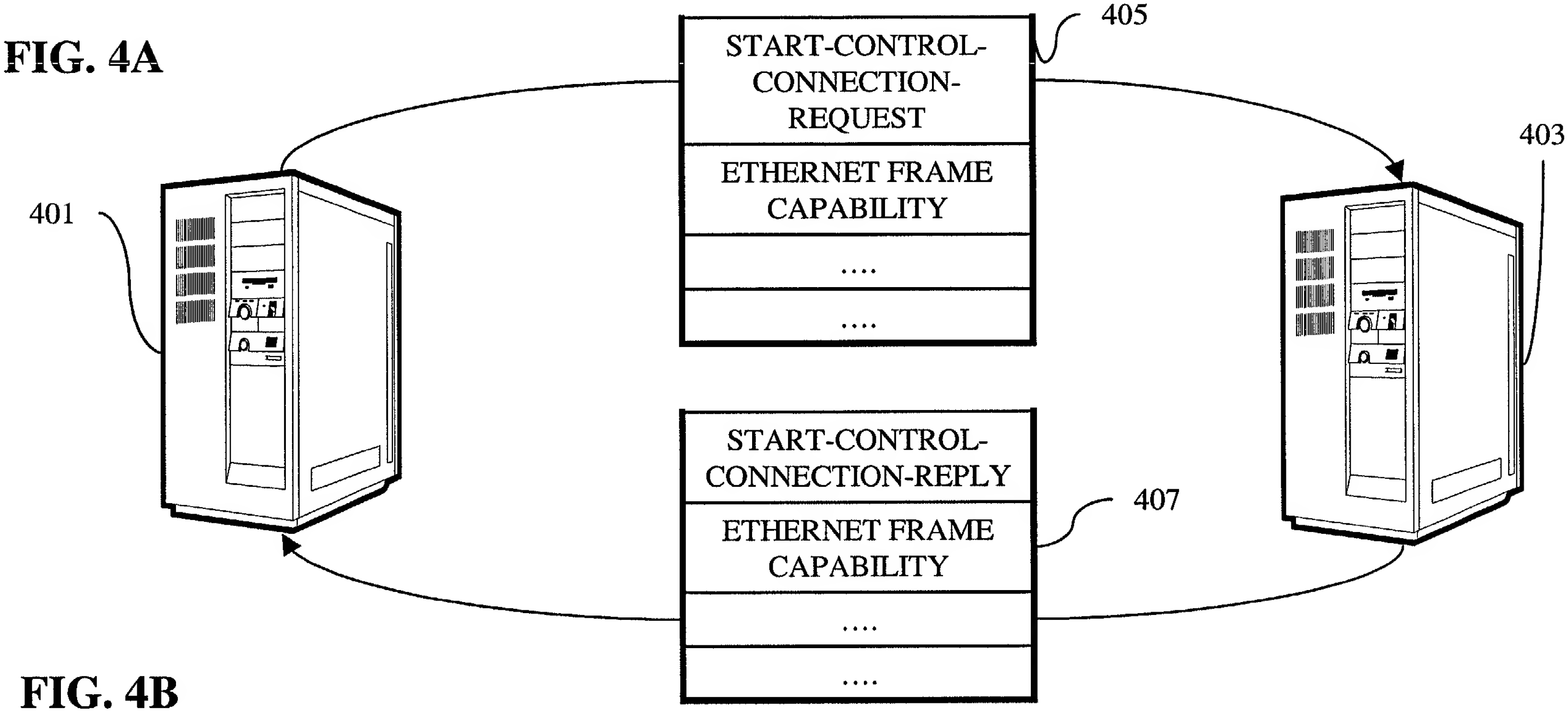
L2TP
DELIVERY
310
317
329

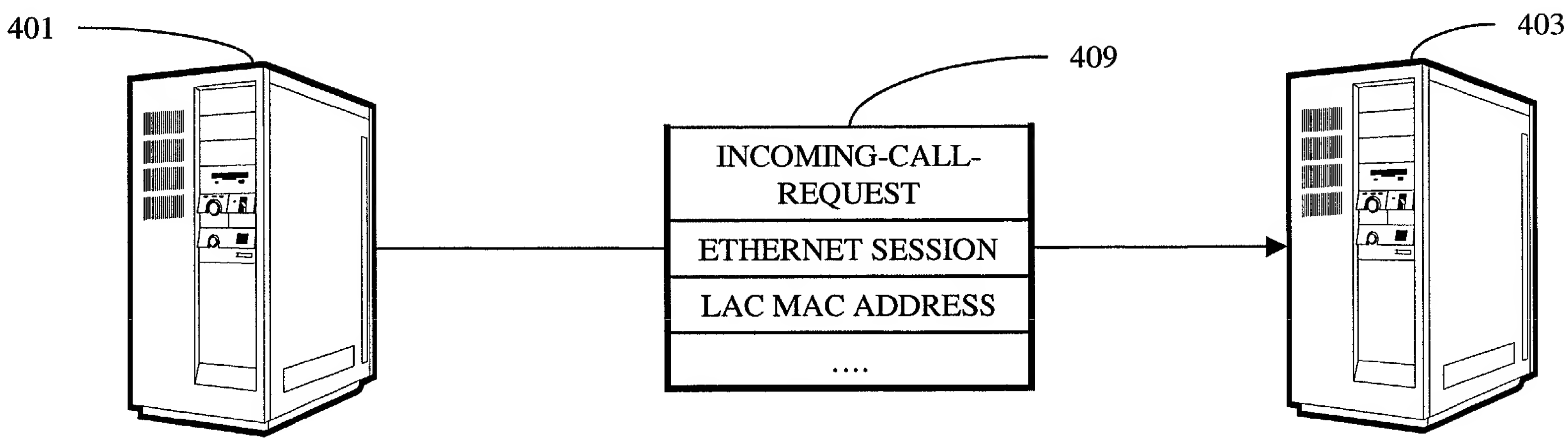
FIG. 3

FIG. 4A



START-CONTROL-CONNECTION-REQUEST
ETHERNET FRAME CAPABILITY
....
....
START-CONTROL-CONNECTION-REPLY
ETHERNET FRAME CAPABILITY
....
....
401
403
405
407

FIG. 4B



INCOMING-CALL-REQUEST
ETHERNET SESSION
LAC MAC ADDRESS
....
401
403
409

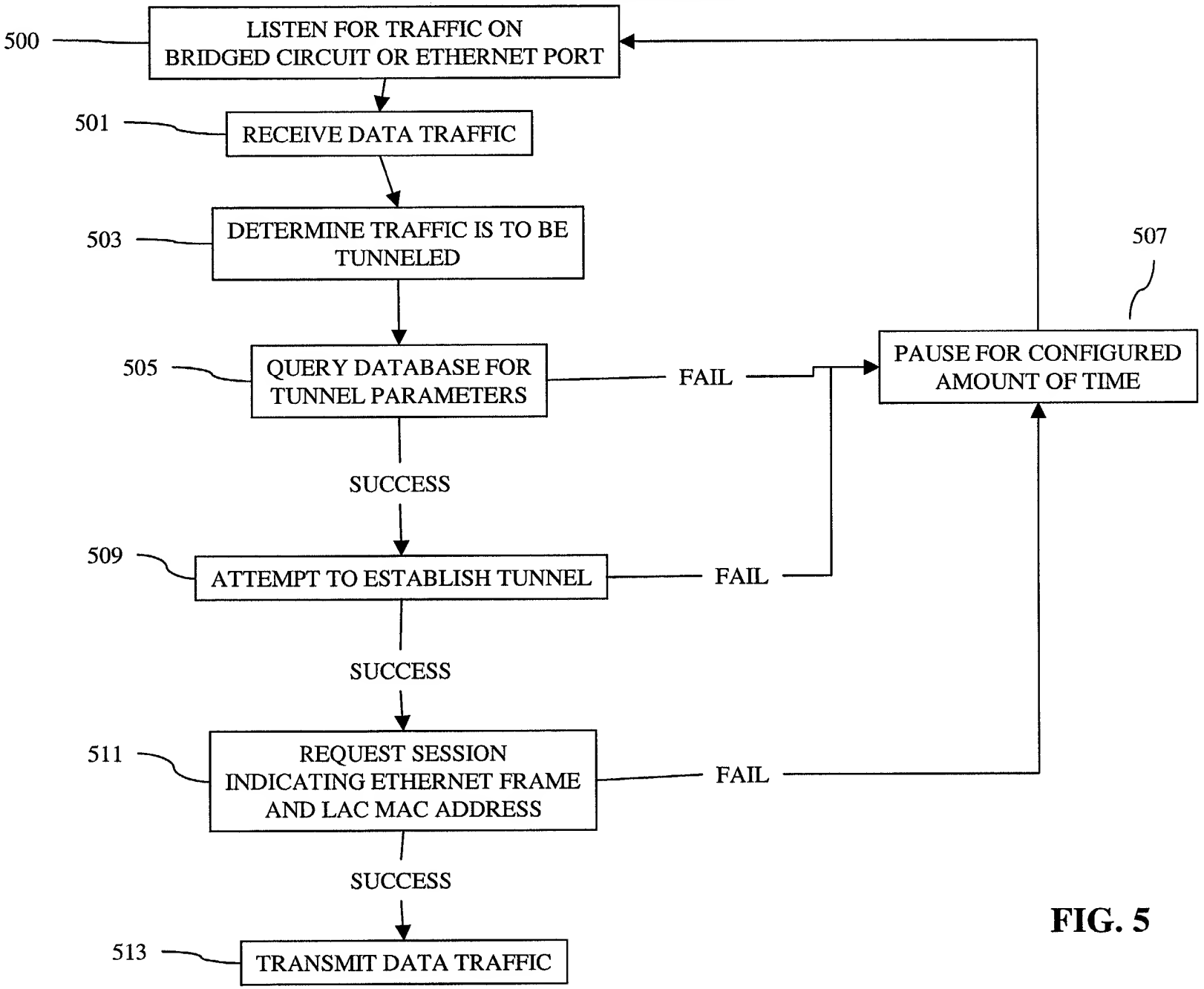

500
LISTEN FOR TRAFFIC ON BRIDGED CIRCUIT OR ETHERNET PORT
501
RECEIVE DATA TRAFFIC
503
DETERMINE TRAFFIC IS TO BE TUNNELED
505
QUERY DATABASE FOR TUNNEL PARAMETERS
FAIL
SUCCESS
509
ATTEMPT TO ESTABLISH TUNNEL
FAIL
SUCCESS
511
REQUEST SESSION INDICATING ETHERNET FRAME AND LAC MAC ADDRESS
FAIL
SUCCESS
513
TRANSMIT DATA TRAFFIC
507
PAUSE FOR CONFIGURED AMOUNT OF TIME

FIG. 5

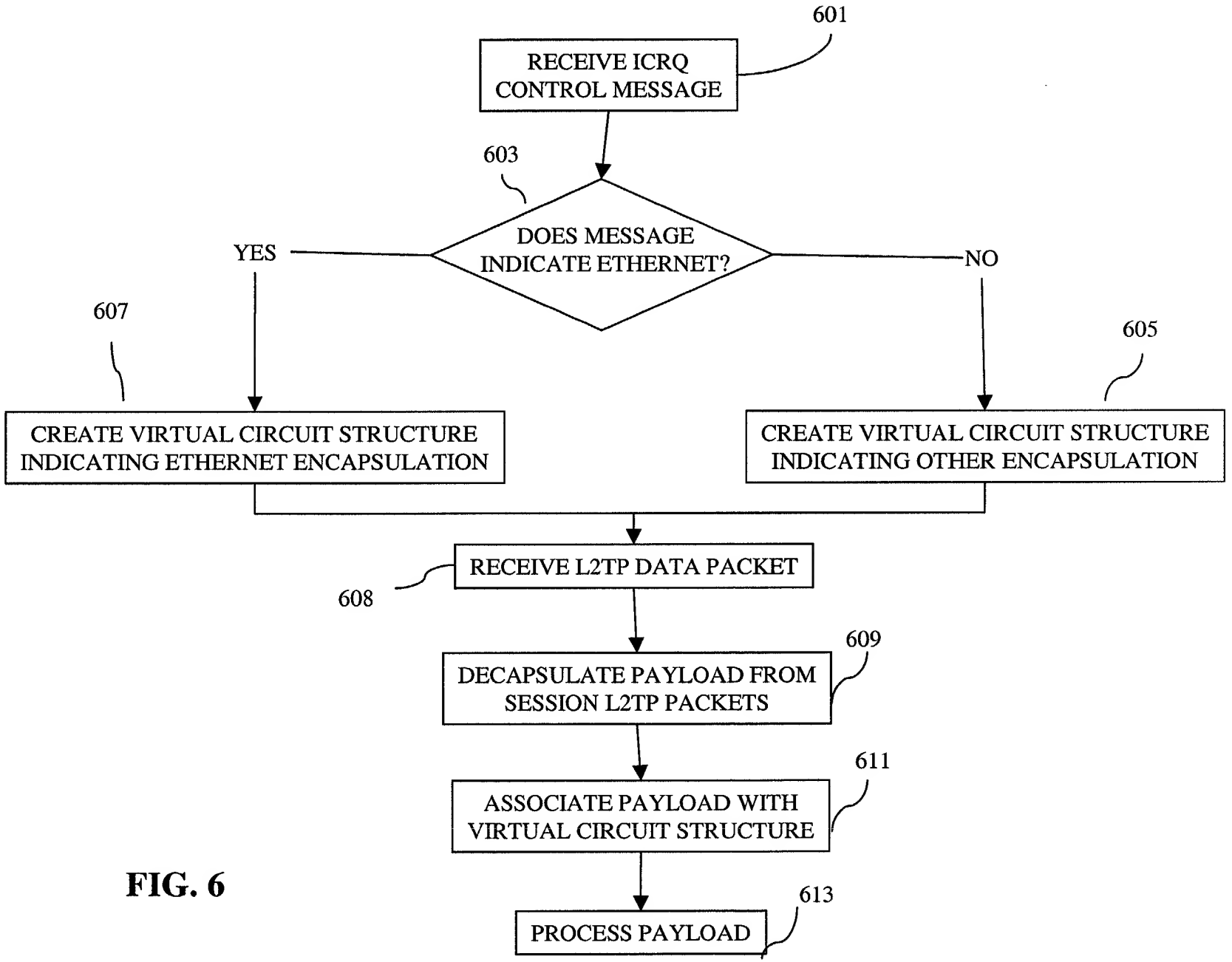

601
RECEIVE ICRQ CONTROL MESSAGE
603
DOES MESSAGE INDICATE ETHERNET?
YES
NO
607
CREATE VIRTUAL CIRCUIT STRUCTURE INDICATING ETHERNET ENCAPSULATION
605
CREATE VIRTUAL CIRCUIT STRUCTURE INDICATING OTHER ENCAPSULATION
608
RECEIVE L2TP DATA PACKET
609
DECAPSULATE PAYLOAD FROM SESSION L2TP PACKETS
611
ASSOCIATE PAYLOAD WITH VIRTUAL CIRCUIT STRUCTURE
613
PROCESS PAYLOAD

FIG. 6

Attorney's Docket No.: 004906.P003 PATENT

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

TUNNELING ETHERNET

the specification of which

X is attached hereto.
___ was filed on _____ as
United States Application Number _____
or PCT International Application Number _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
Number	Country	Day/Month/Year Filed	Yes	No
Number	Country	Day/Month/Year Filed	Yes	No
Number	Country	Day/Month/Year Filed	Yes	No

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

Application Number	Filing Date
Application Number	Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

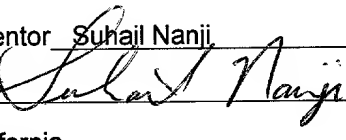
Application Number	Filing Date	Status -- patented, pending, abandoned
Application Number	Filing Date	Status -- patented, pending, abandoned

I hereby appoint the persons listed on Appendix A hereto (which is incorporated by reference and a part of this document) as my respective patent attorneys and patent agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Daniel M. DeVos (Name of Attorney or Agent), BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, 12400 Wilshire Boulevard 7th Floor, Los Angeles, California 90025 and direct telephone calls to Daniel M. DeVos (Name of Attorney or Agent), (408) 720-8598.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor Suhail Nanji

Inventor's Signature  Date 10/26/00

Residence San Jose, California (City, State) Citizenship USA (Country)

Post Office Address 5376 Beaumont Canyon Drive, San Jose, CA

Full Name of Sole/First Inventor _____

Inventor's Signature _____ Date _____

Residence _____ (City, State) Citizenship _____ (Country)

Post Office Address _____

Full Name of Sole/First Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

(City, State) (Country)

Post Office Address _____

_____

Full Name of Sole/First Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____
(City, State) (Country)

Post Office Address _____

Full Name of Sole/First Inventor _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____
(City, State) (Country)

Post Office Address _____

_____

APPENDIX A

William E. Alford, Reg. No. 37,764; Farzad E. Amini, Reg. No. P42,261; Aloysius T. C. AuYeung, Reg. No. 35,432; William Thomas Babbitt, Reg. No. 39,591; Carol F. Barry, Reg. No. 41,600; Jordan Michael Becker, Reg. No. 39,602; Bradley J. Bereznak, Reg. No. 33,474; Michael A. Bernadicou, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; Gregory D. Caldwell, Reg. No. 39,926; Ronald C. Card, Reg. No. P44,587; Thomas M. Coester, Reg. No. 39,637; Stephen M. De Klerk, under 37 C.F.R. § 10.9(b); Michael Anthony DeSanctis, Reg. No. 39,957; Daniel M. De Vos, Reg. No. 37,813; Robert Andrew Diehl, Reg. No. 40,992; Matthew C. Fagan, Reg. No. 37,542; Tarek N. Fahmi, Reg. No. 41,402; James Y. Go, Reg. No. 40,621; James A. Henry, Reg. No. 41,064; Willmore F. Holbrow III, Reg. No. P41,845; Sheryl Sue Holloway, Reg. No. 37,850; George W Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; Dag H. Johansen, Reg. No. 36,172; William W. Kidd, Reg. No. 31,772; Erica W. Kuo, Reg. No. 42,775; Michael J. Mallie, Reg. No. 36,591; Andre L. Marais, under 37 C.F.R. § 10.9(b); Paul A. Mendonsa, Reg. No. 42,879; Darren J. Milliken, Reg. 42,004; Lisa A. Norris, Reg. No. P44,976; Chun M. Ng, Reg. No. 36,878; Thien T. Nguyen, Reg. No. 43,835; Thinh V. Nguyen, Reg. No. 42,034; Dennis A. Nicholls, Reg. No. 42,036; Kimberley G. Nobles, Reg. No. 38,255; Daniel E. Ovanezian, Reg. No. 41,236; Babak Redjaian, Reg. No. 42,096; William F. Ryann, Reg. 44,313; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195; Jeffrey Sam Smith, Reg. No. 39,377; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Judith A. Szepesi, Reg. No. 39,393; Vincent P. Tassinari, Reg. No. 42,179; Edwin H. Taylor, Reg. No. 25,129; John F. Travis, Reg. No. 43,203; George G. C. Tseng, Reg. No. 41,355; Joseph A. Twarowski, Reg. No. 42,191; Lester J. Vincent, Reg. No. 31,460; Glenn E. Von Tersch, Reg. No. 41,364; John Patrick Ward, Reg. No. 40,216; Charles T. J. Weigell, Reg. No. 43,398; Kirk D. Williams, Reg. No. 42,229; James M. Wu, Reg. No. P45,241; Steven D. Yates, Reg. No. 42,242; Ben J. Yorks, Reg. No. 33,609; and Norman Zafman, Reg. No. 26,250; my patent attorneys, and Andrew C. Chen, Reg. No. 43,544; Justin M. Dillon, Reg. No. 42,486; Paramita Ghosh, Reg. No. 42,806; and Sang Hui Kim, Reg. No. 40,450; my patent agents, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, and James R. Thein, Reg. No. 31,710, my patent attorney.

APPENDIX B

Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclosure all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made or record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.